RADIONUCLIDES

Radionuclides (including radon) are federal hazardous air pollutants and were identified as toxic air contaminants in April 1993 under AB 2728.

CAS Registry Number: Radon 10043-92-2 ^{222}Rn ^{131}I
Iodine 7553-56-2

Molecular Formula: Rn
I

In this fact sheet radionuclides are defined as ^{122}radon and ^{131}iodine. Radon is a radioactive, colorless, odorless, inert gas. It is the heaviest gas known and can be condensed to a colorless, transparent liquid or an opaque, glowing solid. It is a product of radioactive decay of radium. Radon is soluble in water, and slightly soluble in alcohol and organic liquids. Of radon's 18 radioactive isotopes, ^{222}radon is the longest lived (Sax, 1987).

^{131}Iodine is a halogen, diatomic, and occurs as rhombic, violet-black crystals, with a metallic luster. Iodine has a characteristic odor and a sharp acrid taste. It is soluble in chloroform, glacial acetic acid, glycerol oils, and aqueous solutions of iodides. Reducing materials react vigorously with iodine (Sax, 1989). ^{131}Iodine is an artificial iodine isotope derived by pile irradiation of tellurium and from the fission products of nuclear reactor fuels. It is available as elemental iodine and in a weakly basic solution of sodium iodide in sodium sulfite. ^{131}Iodine is also available in isotopically-labeled compounds such as dithymol diiodide, potassium iodate, diiodofluorescein, insulin, and adrenocorticotropic hormone (ACTH) (Sax, 1987).

Physical Properties of ^{222}Radon and ^{131}Iodine

Synonyms: None

	^{222}Radon	^{131}Iodine
Atomic Number:	86	53
Atomic Weight:	222	131
Radiation Emissions:	alpha	beta and gamma
Boiling Point:	-62 ºC	185.24 ºC
Melting Point:	-71 ºC	113.5 ºC
Density:	9.73 at 0 ºC	4.93 (solid, 25 ºC)
Vapor Pressure:	1 mm Hg at -144.2 ºC	1 mm Hg at 38.7 ºC

(HSDB, 1991; Merck, 1989; Sax, 1989; U.S. EPA, 1994a)

SOURCES AND EMISSIONS

A. Sources

^{222}Radon appears naturally in most soils and rock and in extremely small amounts in uranium minerals. ^{122}Radon is found in detectable amounts indoors. The source of indoor ^{222}radon is soil and rock underneath buildings, building materials, and water sources. ^{222}Radon is used in medicine for cancer treatment, as a tracer in leak detection, in flow rate measurement, in radiography, and in chemical research (Sax, 1987).

^{131}Iodine is available in tagged compounds such as dithymol diiodide, potassium iodate, diiodofluorescein, insulin, and ACTH. It is used in the diagnosis and treatment of thyroid disorders; internal radiation therapy; in film gauges to measure film thicknesses; for detecting leaks in water lines; as a source of radiation in oil field tests; as a tracer in chemical analysis; and, as a tracer in studying the efficiency of mixing pulp fibers and the thermal stability of potassium iodate in bread dough (Sax, 1987).

The primary stationary sources that have reported emissions of radionuclides including radon in California are steam and air conditioning supply services, electrical services, and petroleum refining (ARB, 1997b).

B. Emissions

The total emissions of radionuclides (including radon) from stationary sources in California are estimated to be at least 15,000 curies per year, based on data reported under the Air Toxics "Hot Spots" Program (AB 2588) (ARB, 1997b). Of the 15,000 curies of emissions, at least 430 curies are from radon.

C. Natural Occurrence

It is estimated that every square mile of soil to a depth of 6 inches contains about 1 gram of radium. One gram of radium produces about 0.0001 milliliters of radon per day at normal temperature and pressure (HSDB, 1991).

AMBIENT CONCENTRATIONS

No Air Resources Board data exist for ambient concentrations of radionuclides.

INDOOR SOURCES AND CONCENTRATIONS

The ARB sponsored the first statewide study to measure residential radon concentrations (ARB, 1990h). Average California indoor radon concentrations in 384 residences were found to be much lower than those in most other states. The annual average radon concentration

statewide was 0.85 picocuries per liter (pCi/L). However, about one percent of California homes was estimated to have average radon concentrations exceeding 4.0 pCi/L; the level at which the United States Environmental Protection Agency (U.S. EPA) recommends that mitigation measures be taken to protect inhabitants. In general, indoor radon concentrations were significantly higher than outdoor concentrations, and basement concentrations were significantly higher than living-area concentrations. Thirty-seven homes in the Sierra Nevada foothills had an annual average radon concentration of 1.28 pCi/L. Areas of Ventura County had radon concentrations slightly above the recommended action level (ARB, 1990h).

The California Department of Health Services (DHS) and the U.S. EPA, Region 9, subsequently conducted a larger statewide residential radon study. Results of that study are in general agreement with the ARB-sponsored study. Average indoor levels in California counties measured under worst-case conditions ranged from 0.3 pCi/L to 2.7 pCi/L (U.S. EPA, 1993h). Only three counties had a maximum indoor measurement above 20 pCi/L. Most counties had zero or a few percent of measurements above 4 pCi/L; several had more than 5 percent of measurements above 4 pCi/L. As found in the earlier study, most of the elevated radon levels were found in the Sierra Nevada counties and the southern coastal mountain counties.

The DHS also conducted a study of 6608 classrooms in 376 schools statewide during the 1992-93 school year. Thirty-seven classrooms (about 0.5 percent) and 14 schools (about 3.5 percent) had radon levels greater than 4 pCi/L (Quinton, 1996). The highest radon level found was 12.8 pCi/L.

ATMOSPHERIC PERSISTENCE

^{222}Radon has a half-life of 3.823 days (Merck, 1989) and iodine a half-life of 8 days (Sax, 1987).

AB 2588 RISK ASSESSMENT INFORMATION

Although radionuclides are reported as being emitted in California from stationary sources no health values (cancer or non-cancer) are listed in the California Air Pollution Control Officers Association Air Toxics “Hot Spots” Program Revised 1992 Risk Assessment Guidelines for use in risk assessments (CAPCOA, 1993).

HEALTH EFFECTS

Probable routes of human exposure to radionuclide emissions are inhalation and ingestion (Amdur, 1991; Amdur, 1986).

Non-Cancer: Short-term over-exposure to internal or external doses of ionizing radiation from radionuclides may cause damage to tissue; especially rapidly dividing tissue such as the lining

of the gastrointestinal tract and the hematopoietic system. Very large doses of ionizing radiation may destroy the nervous system, causing death (Amdur, 1991; Amdur, 1986). Long-term inhalation of uranium and radon may cause respiratory effects, while exposure to radium may cause acute leukopenia, anemia, and necrosis of the jaw (U.S. EPA, 1994a).

The (U.S. EPA) has established an oral Reference Dose (RfD) of 0.003 milligrams per kilogram per day for uranium (soluble salts) based on body weight loss and moderate nephrotoxicity in rabbits. The U.S. EPA estimates that consumption of this dose or less over a lifetime would not likely result in the occurrence of chronic, non-cancer effects. The U.S. EPA has not established a Reference Concentration (RfC) for uranium (soluble salts or natural). The U.S. EPA has not established an oral RfD or RfC for radium or radon (U.S. EPA, 1994a).

Limited evidence from epidemiological studies suggests that uranium or radon exposure may result in a decreased ratio of live male to female births in humans. Adverse reproductive effects have not been reported in animals exposed to uranium by inhalation, while fetal toxicity, reduced offspring, and degenerative changes in the testes were noted from oral exposure in animals. No information is available on adverse reproductive or developmental effects of radium in humans or animals (U.S. EPA, 1994a). The State of California has determined under Proposition 65 that ^{131}iodine is a developmental toxicant (CCR, 1996).

Cancer: Oral exposure to radium may cause lung, bone, brain, and nasal passage tumors in humans. Inhalation exposure to radon may cause lung cancer in humans. Uranium may cause lung cancer and tumors of the lymphatic and hematopoietic tissues. The U.S. EPA has placed radium in Group A: Human carcinogen, and has not classified radon and uranium (U.S. EPA, 1994a). The International Agency for Research on Cancer has classified radon and its decay products in Group 1: Human carcinogen, based on sufficient evidence in humans (IARC, 1988a). The State of California under Proposition 65 has determined that radionuclides are carcinogens (CCR, 1996).